

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
1 April 2004 (01.04.2004)

PCT

(10) International Publication Number
WO 2004/027144 A1

(51) International Patent Classification⁷: D21F 1/00

(21) International Application Number:
PCT/IB2003/005024

(22) International Filing Date:
18 September 2003 (18.09.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
0221643.0 18 September 2002 (18.09.2002) GB

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(81) Designated States (*national*): AE, AG, AL, AM, AT, AU,
AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU,
CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH,
GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC,
LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW,
MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG,
SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC,
VN, YU, ZA, ZM, ZW.

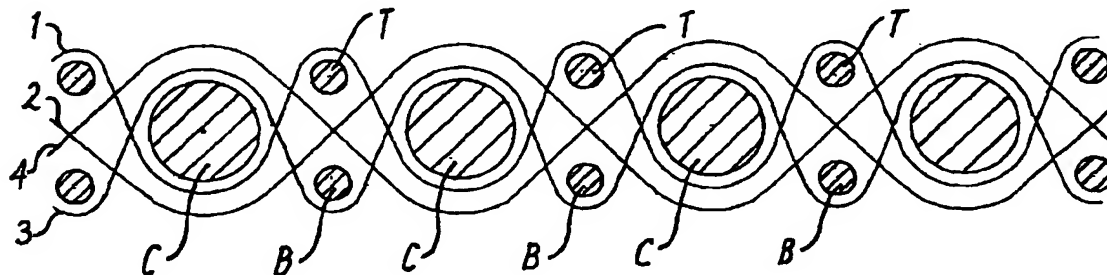
(84) Designated States (*regional*): ARIPO patent (GH, GM,
KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW),
Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),
European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE,
ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO,
SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM,
GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

- with international search report
- before the expiration of the time limit for amending the
claims and to be republished in the event of receipt of
amendments

For two-letter codes and other abbreviations, refer to the "Guid-
ance Notes on Codes and Abbreviations" appearing at the begin-
ning of each regular issue of the PCT Gazette.

(54) Title: PAPER MACHINE CLOTHING WITH WEAR-RESISTANT WEAVE



(57) Abstract: Papermachine clothing, having particular application as a dryer fabric, comprises machine direction (MD) yarns and cross-machine direction (CD) yarns interwoven in a repeat pattern, wherein the CD yarns are provided in two systems. The first CD yarn system comprises upper and lower yarns (T, B) and the second CD yarn system comprising a single yarn ©. The first and second CD systems are provided alternatively throughout the fabric. The MD yarns are also provided in two systems, the first MD yarn system (2, 4) extending inbetween the upper (T) and lower (B) yarns of the first CD yarn system and over the single yarn (C) of the second CD yarn system. Individual yarns (1, 3) of the second MD yarn system extend over one of the upper or lower yarns of the first CD yarn system and the single yarn of the second CD yarn system. Two adjacent machine direction yarns (1, 2) from different MD yarn systems extend as a pair over the same CD yarn of the second CD yarn system with one (2) of said pair of MD yarns extending above the other (1) of said pair such that said other yarn (1) is protected from abrasion.

PAPER MACHINE CLOTHING WITH WEAR-RESISTANT WEAVE

The present invention relates to papermachine clothing and more particularly, but not exclusively, to dryer fabrics for use in the dryer section of a papermaking machine.

5 Paper is conventionally manufactured by conveying a paper furnish, usually consisting of an initial slurry of cellulosic fibres, from a forming section, through a pressing section and ultimately around a drying section of a papermaking machine.

Papermachine clothing is essentially employed to carry the paper web
10 through these various stages of the papermaking machine. In the forming section the fibrous furnish is wet-laid onto a moving forming wire and water is allowed to drain from it. The paper web is then transferred to a press fabric that conveys it through the pressing section, where it is usually passed through a series of pairs of rotating cylindrical press rolls. Water is squeezed from the paper web and into the
15 press fabric as the web and fabric pass through the nip together.

In the final stage the paper web is transferred to a dryer fabric in the dryer section of the papermaking machine. The dryer section conventionally includes a number of rotatable dryer drums or cylinders heated from within by steam. The web is directed over each of these drums by the dryer fabric which holds the web
20 against the surface of the heated drums. In this way the majority of the remaining water is evaporated from the paper web.

Dryer fabrics are generally formed from materials which are resistant to hydrolytic degradation under high temperatures. However, these materials are prone to abrasion. Consequently the dryer fabrics made from these materials have

unacceptably short lives. Numerous solutions have been proposed to this problem. These solutions sometimes involve varying the constituent polymer of the fabric yarns, such as in US 5,692,938 or varying the weave pattern, such as in US 6,158,478 and US 5,503,196.

5 US 6158478 relates to a multilayer woven dryer fabric having a weave pattern in which less knuckles are formed on the machine-side of the fabric than on the paper-side by reducing the number of interweavings that each machine direction (MD) yarn makes with the lowermost cross-machine direction (CD) floats. This produces a machine-contacting surface dominated by a large number
10 of CD yarns which are subjected to abrasion from the machine, thus protecting the strength-providing MD yarns. However, this fabric potentially suffers from the problem of fabric instability in that during a prolonged run it is likely that the fabric weave will come apart at the back.

US 55,03,196 relates to a multilayer dryer fabric comprising two layers of
15 CD yarns of round cross-section and two systems of MD yarns, the first being of round cross-section and the other consisting of flat yarns. The MD yarns in the first system of MD yarns are interwoven with the CD yarns in the first and second layers in a duplex weave and bind the first and second layers of CD yarns together. The MD yarns in the second system of MD yarns are interwoven with
20 either the first or second layers of CD yarns.

The knuckles of the first round MD yarn system are said to be within the fabric with respect to the planes defined by the second system of flat MD yarns and as a consequence are said to be less susceptible to degradation by heat and abrasion.

However, this fabric would be extremely sleezy and not particularly stable as the whole structure is bound together by just the central round MD yarns, as the upper and lower MD yarns only offer minimal binding and for the most part float on either external surface. Sleezy fabrics suffer from yarn wear, as a result of internal friction, and changes in permeability resulting in undesirable differential dewatering of the paper web.

According to the present invention there is provided papermachine clothing comprising machine direction (MD) yarns and cross-machine direction (CD) yarns interwoven in a repeat pattern such that, on at least one side of the fabric, as part of the weave pattern, two adjacent machine direction yarns extend over the same CD yarn as a pair with one of said pair of MD yarns extending above the other of said pair such that said other yarn is protected from abrasion.

According to a second aspect of the present invention there is provided papermachine clothing comprising machine direction (MD) yarns and cross-machine direction (CD) yarns interwoven in a repeat pattern, wherein the CD yarns are provided in two systems, the first CD yarn system comprising upper and lower yarns, the second CD yarn system comprising at least one yarn, the first and second CD systems being provided alternately throughout the fabric, and wherein the MD yarns are provided in two systems, the first MD yarn system extending inbetween the upper and lower yarns of the first CD yarn system and over the at least one yarn of the second CD yarn system and individual yarns of the second MD yarn system extending around one of the upper or lower yarns of the first CD yarn system and the at least one yarn of the second CD yarn system, and wherein two adjacent machine direction yarns from different MD yarn systems extend as a

pair over the same CD yarn of the second CD yarn system with one of said pair of MD yarns extending above the other of said pair such that said other yarn is protected from abrasion.

5 The fabric weave of the invention, in arranging some of the machine direction yarns in pairs with half of these being higher than the adjacent yarn in the pair, providing protection against abrasion for the lower MD yarn. Therefore, a considerable number of the strength-providing machine direction yarns are protected from abrasion for a considerable time within a highly stable weave structure.

10 The MD yarns are preferably flat, round or square in cross-section. In a preferred embodiment of the invention the MD yarns are flat having preferred dimensions in the range from 0.30 – 0.45 x 0.50 – 0.80 mm. The CD weft yarns are ideally round or flat. In a preferred embodiment of the invention the CD yarns are round in cross-section. Ideally two systems of CD yarns are used, the first
15 system preferably comprising upper and lower yarns. The diameter of the CD yarns of the first CD yarn system is ideally in the range from 0.20 – 0.80 mm. The diameter of the CD yarns of the second CD yarn system is ideally in the range from 0.50 – 1.50 mm. The second CD yarn system ideally resides within the fabric with respect to the top and base of the first CD yarn system.

20 The fabric of the invention preferably has a permeability in the range from 90-300 cfm.

In order that the present invention may be more readily understood a specific embodiment thereof will now be described by way of the accompanying drawings in which:-

Fig.1 is a plan view micrograph of one fabric in accordance with the present invention;

Fig.2 is a diagram showing the weave pattern of the fabric of Fig.1;

Fig.3 is a table showing the weave pattern of the fabric of Fig.1;

5 Fig. 4 is a series of micrographs showing the results of abrasion tests on the fabric of Fig. 1;

Fig. 5 is a graph showing the reduction of caliper and tensile strength of the fabric of Fig. 1 as a consequence of abrasion;

Fig. 6 is a graph comparing the reduction of caliper and tensile strength of the fabric of Fig. 1 with a prior art fabric as a consequence of abrasion; and

Fig. 7 is a graph comparing the reduction of caliper and tensile strength of the fabric of Fig. 1 with a second prior art fabric as a consequence of abrasion

Referring to Figs. 1-3 a papermakers fabric particularly for use in the dryer section of a papermaking machine is woven from flat MD warp yarns (0.36mm x 15 0.67mm) and two systems of CD wefts/picks which are round in cross-section. The first system of CD yarns comprises a pair of vertically stacked CD yarns, i.e. top (T) and bottom (B) yarns, which are 0.4mm in diameter. The second system of CD yarns comprises larger wefts, arranged alone, which are 0.7mm in diameter. The two CD yarn systems are arranged alternately through the fabric.

20 Fig.2 clearly shows that the weave is a four warp yarn repeat within two warp paths. Warps 1 and 3 follow one path such that the warps hug the external faces of each of the T, B and C weft yarns. Warps 2 and 4 follow an alternative path passing between the upper T and lower B picks of the first CD yarn system and then around weft C. Warps 1 and 3 of the 2nd MD yarn system are protected

by warp yarns 2 and 4 of the 1st yarn system. It can be seen from Fig. 2 that the weave is symmetrical about a central horizontal plane.

Fig. 3 is a table showing the exact weave pattern of the fabric of Figs. 1 and 2. In the table "LHS" is the left hand weft presenter, "RHS" is the right hand weft presenter and "Dir" is the direction of travel of the weft yarn. As is conventional with tables of this kind a cross in a box underneath any of the sheds/warps means that the specific warp extends over the associated weft.

Therefore we can follow the path of any given warp with reference to the table of Fig. 3 and also the drawing of Fig. 2. For example, the number 1 warp from Figs. 2 and 3 can be seen to pass over T & B weft yarns 1, 2, under C weft yarn 3, over T & B weft yarns 4, 5, under 6, over yarns 7, 8, under 9, over 10, 11 and finally under 12.

As stated previously, the weave is a four warp repeat; i.e. after the first four warps, the pattern repeats so warps 5 and 9 follow the same path as warp 1, warps 6 and 10 follow the same path as warp 2 and so on.

The woven fabric is clearly identified in Figs. 1 and 2, where the abrasion resistance of the fabric is readily apparent. Warps 1 and 3 are protected from abrasion by warp yarns 2 or 4 from the other pair, as they extend around pick C. Warps 1 and 3 follow a convoluted path around the external edges of each of the weft yarns and become tightly wrapped around these yarns. A combination of this 'hugging' effect and the beat up forces of the loom lead to a high degree of crimp. In comparison, yarns 2 and 4 extend around the large weft yarns, but then pass between T and B picks, so taking a far less severe path and subsequently the yarns are less crimped and fall outside warps 1 and 3, thereby protecting them from

abrasion. In all cases, warp 3 is protected from abrasion on the upper surface and warp 1 on the lower surface by warp yarns 2 and 4 alternately. In Fig. 1 it can be seen that the protected yarn 3 is provided to the left of warp 2 and to the right of warp 4.

5 During manufacture of the fabric two beams are required to deliver the warp yarns to the healds due to the difference in the path lengths of the two warp paths of warps 1 and 3 compared to that of warps 2 and 4. Also two weft presenters are used. One weft presenter presents either the top or bottom weft of the first CD yarn system. The other weft presenter presents the larger central weft
10 yarn of the second CD yarn system.

Referring to the table of Fig. 3, looking across the first row from right to left (i.e. the direction of travel of the weft yarn), it can be seen that the first weft (top) is fired over warps 12, 11 and 10, under warp 9, over warps 8, 7 and 6, under warp 5, and as can be seen in Fig. 2, over warps 4, 3 and 2, but below warp 1.
15 The second weft selected is a bottom weft and this is picked up by the shuttle on the left hand side and taken across the loom. As can be seen in Fig. 2, weft 2 passes under warps 1 and 2, above 3 and then below 4. It then continues (not visible in Fig. 2), under warps 5 and 6, over 7, under 8, 9 and 10, over 11 and under 12.

20 The protected MD yarns 1,3 are advantageously selected to form the seam loops or to bind to a jointing means such as a spiral.

Fig. 4 is a series of twelve micrographs, taken periodically after the fabric of Fig. 1 has been subjected to abrasion. The abrasion story is illustrated from 0 to 1632 hours.

After 96 hours, it can be seen that the uppermost warp knuckles have just started to be abraded and this continues gradually until micrograph 6. After 888 hours (micrograph 7) it can be seen that the most prominent weft yarn T is beginning to be abraded. At this point, an interesting phenomenon was observed.

5 Once the abrasion reaches weft yarn T, it seems to halt at this point, the weft yarn T thus protecting the second warp of the pair from further abrasion. The abrasion tests were stopped after 1632 hours. At this point, the abrasion seemed not to be any further advanced than after 888 hours, and there still appeared to be plenty of life remaining in the fabric. The micrographs clearly show that the second warp

10 yarn of each warp pair is entirely free of abrasion for many hours after the onset of abrasion in its neighbouring yarn.

Figs. 5 to 7 show the results of a number of tests which were carried out to discover, in the same time frames, how the tensile strength and caliper of the fabric were affected by the abrasion. These have been plotted for the fabric of the invention alone, in Fig. 5, and as compared with two prior art dryer fabrics – “Art

15 1” & “Art 2”, in Figs. 6 and 7 respectively.

In Fig. 5 it can be seen that the caliper of the fabric of the invention is only reduced by just over 13% of its original value after 1632 hours, and that the tensile strength until 1392 hours was 70% of its original value, but then fell fairly steeply

20 to just over 45% at the end of the trial. This value though is well above the critical tensile value, i.e. the value below which the fabric is rendered unusable, of just under 30%.

Fig. 6 shows that the fabric of the invention performs well against the “Art 1” dryer fabric which only has a lifetime of around 240 hours, at which point the critical tensile strength had been surpassed.

In Fig. 7 the performance of the fabric of the invention is shown as against the “Art 2” dryer fabric. Here the caliper percentage figures are very similar until around 1536 hours, at which time, Art 2 shows a sharper decline in caliper. The tensile strength of the fabric of the invention is consistently lower than that of Art 2, but after 1632 hours the Art 2 fabric had surpassed its critical tensile value and became unusable, whereas the fabric of the invention still had 45% of its original tensile strength.

It is to be understood that the above disclosed embodiment of the invention is by way of illustration only. Many modifications and variations are possible.

CLAIMS

1. Papermachine clothing comprising machine direction (MD) yarns and cross-machine direction (CD) yarns interwoven in a repeat pattern such that, on at least one side of the fabric, as part of the weave pattern, two adjacent machine
5 direction yarns extend over the same CD yarn as a pair with one of said pair of MD yarns extending above the other of said pair such that said other yarn is protected from abrasion.
2. Papermachine clothing as claimed in claim 1, wherein the CD yarns are provided in two systems, as a first CD yarn system and a second CD yarn system.
- 10 3. Papermachine clothing as claimed in claim 2, wherein the two CD yarn systems are provided alternately through the fabric.
4. Papermachine clothing as claimed in claim 2 or claim 3, wherein the first CD yarn system comprises stacked upper and lower yarns.
5. Papermachine clothing as claimed in any of claims 2, 3 or 4, wherein the
15 second CD yarn system comprises a single yarn.
6. Papermachine clothing as claimed in claim 4, wherein yarns of a first MD yarn system extend inbetween the upper and lower yarns of the first CD yarn system.
7. Papermachine clothing as claimed in claim 6, wherein yarns of a second
20 MD yarn system extends over one of the upper or lower yarns of the first CD yarn system and over the yarn of the second CD yarn system.
8. Papermachine clothing comprising machine direction (MD) yarns and cross-machine direction (CD) yarns interwoven in a repeat pattern, wherein the CD yarns are provided in two systems, the first CD yarn system comprising upper

and lower yarns, the second CD yarn system comprising at least one yarn, the first and second CD systems being provided alternately throughout the fabric, and wherein the MD yarns are provided in two systems, the first MD yarn system extending inbetween the upper and lower yarns of the first CD yarn system and
5 over the at least one yarn of the second CD yarn system and individual yarns of the second MD yarn system extending around one of the upper or lower yarns of the first CD yarn system and the at least one yarn of the second CD yarn system, and wherein two adjacent machine direction yarns from different MD yarn systems extend as a pair over the same CD yarn of the second CD yarn system
10 with one of said pair of MD yarns extending above the other of said pair such that said other yarn is protected from abrasion.

9. Papermachine clothing as claimed in any preceding claim, wherein the MD yarns are flat in cross-section.

10. Papermachine clothing as claimed in claim 9, wherein the dimensions of
15 the MD yarns are in the range from 0.30 – 0.45 x 0.50 – 0.80mm.

11. Papermachine clothing as claimed in any preceding claim, wherein the CD yarns are round in cross-section.

12. Papermachine clothing as claimed in claim 2 or claim 8, wherein the diameter of CD yarns in the first CD yarn system is in the range from 0.20 to
20 0.80mm.

13. Papermachine clothing as claimed in claim 2 or claim 8, wherein the diameter of the CD yarns in the second CD yarn system is in the range from 0.50 to 1.50mm.

14. Papermachine clothing as claimed in any preceding claim, having a permeability in the range from 90 – 300cfm.
15. The use of papermachine clothing as claimed in any preceding claim as a dryer fabric in a papermaking machine.

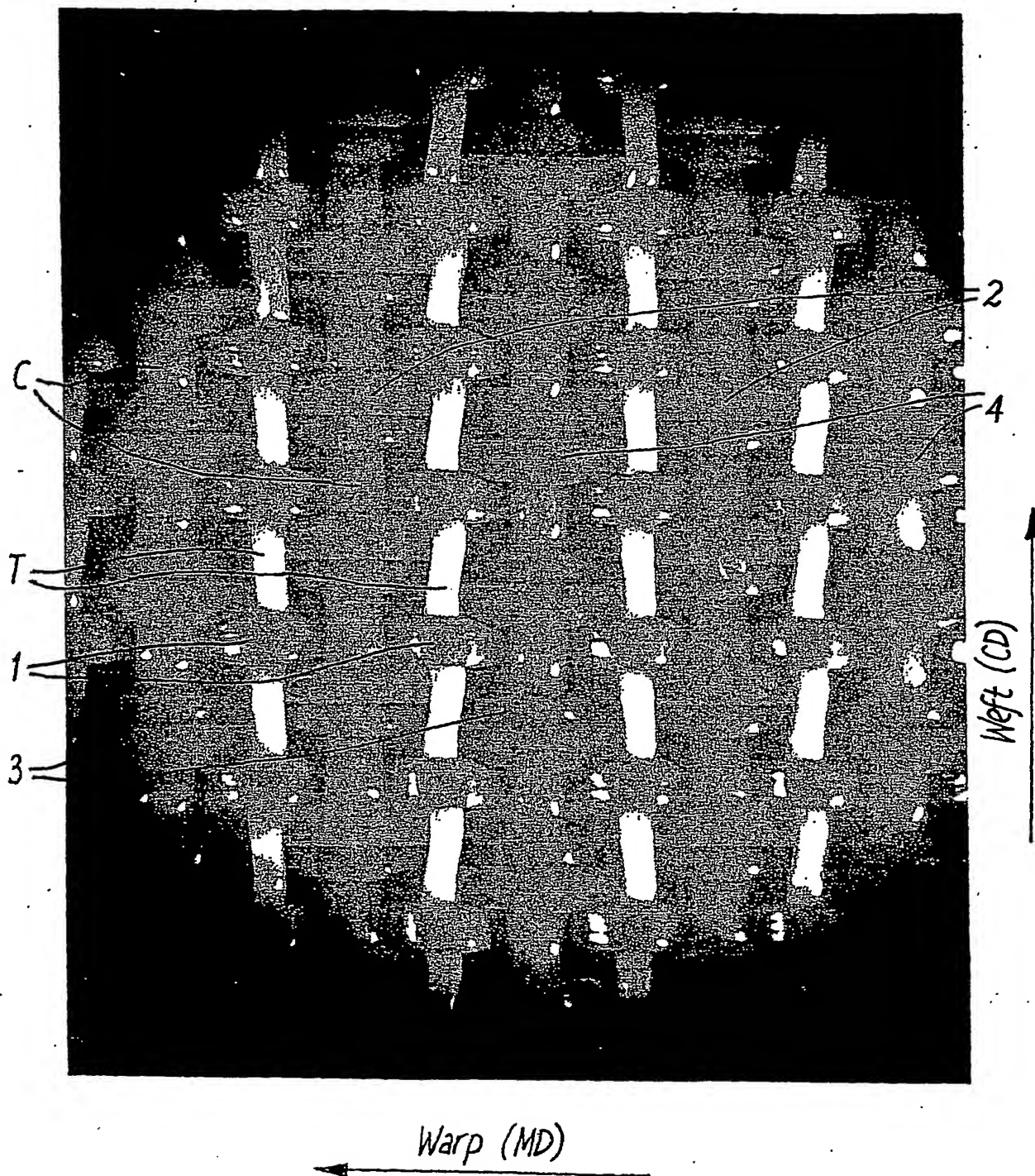


FIG. 1

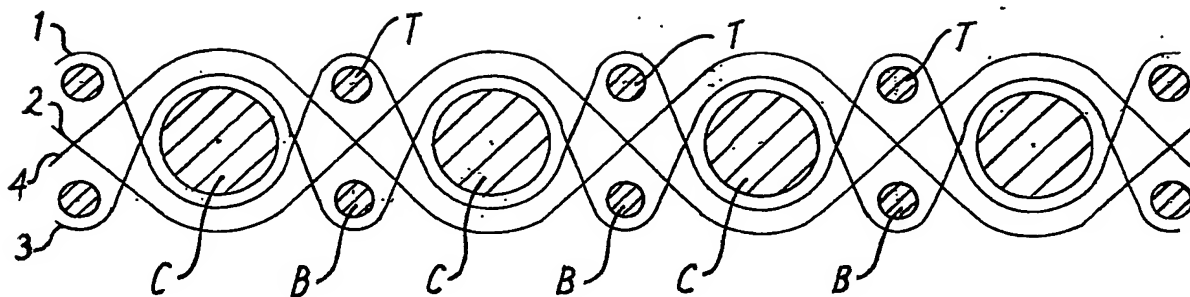


Fig. 2

WEAR RESISTANT WEAVE
Weave Pattern

Picks (Wefts)	LHS Weft Pres	SHEDS (Warps)												RHS Weft Pres	Dir	Layer of Weft
		1	2	3	4	5	6	7	8	9	10	11	12			
1		X				X				X				1	←	T
2	1	X	X		X	X	X		X	X	X		X		→	B
3				X	X			X	X			X	X	3	←	C
4	1	X				X				X					→	T
5		X	X		X	X	X		X	X	X		X	1	←	B
6	3		X	X			X	X			X	X			→	C
7		X				X				X				1	←	T
8	1	X	X		X	X	X		X	X	X		X		→	B
9				X	X			X	X			X	X	3	←	C
10	1	X				X				X					→	T
11		X	X		X	X	X		X	X	X		X	1	←	B
12	3		X	X			X	X			X	X			→	C

Top & Bottom Weft 0.40mm. Centre Weft 0.70mm. Warp 0.36 x 0.67mm

Fig. 3

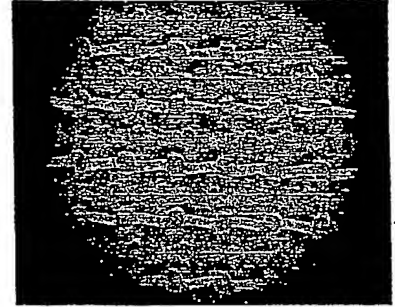
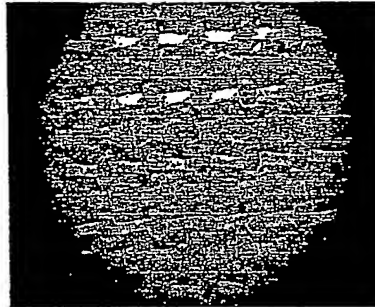
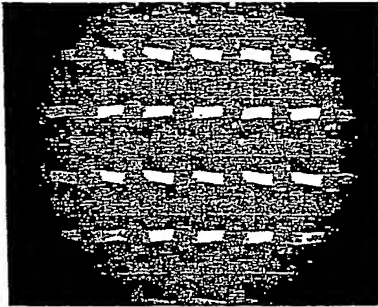
F18 Wear Weave – Abrasion Photo's to Date

25 Mar 2002

1

2

3



0 Hours

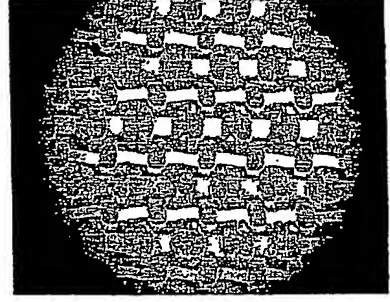
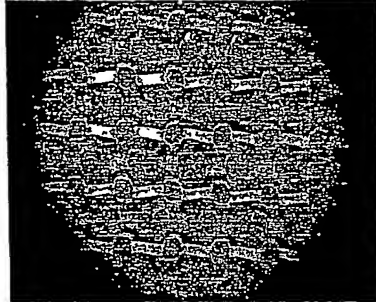
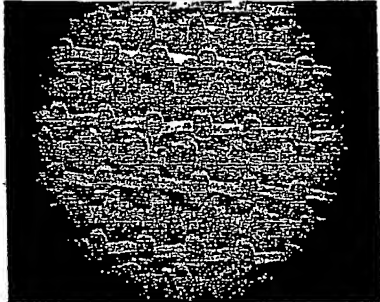
96 Hours

192 Hours

4

5

6



288 Hours

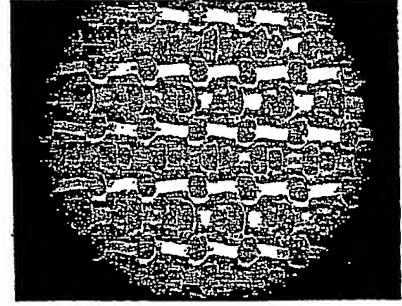
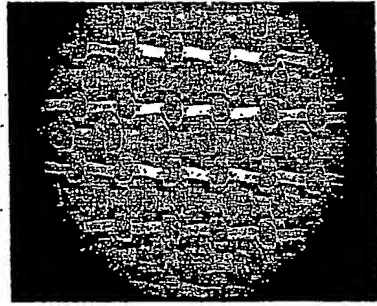
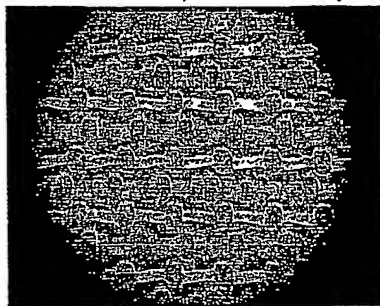
384 Hours

696 Hours

7

8

9



888 Hours

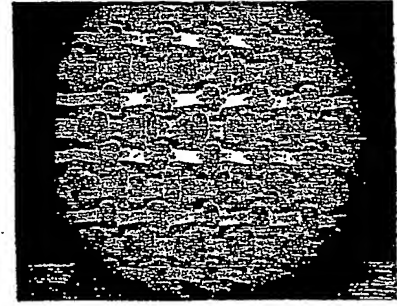
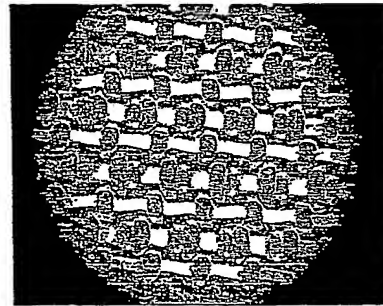
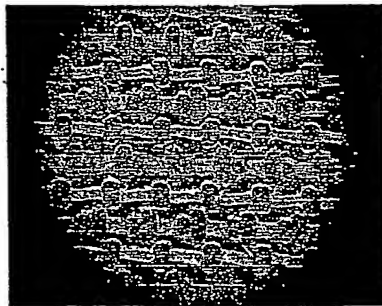
1056 Hours

1248 Hours

10

11

12



1392 Hrs

1536 Hrs

1632 Hrs

F18.4

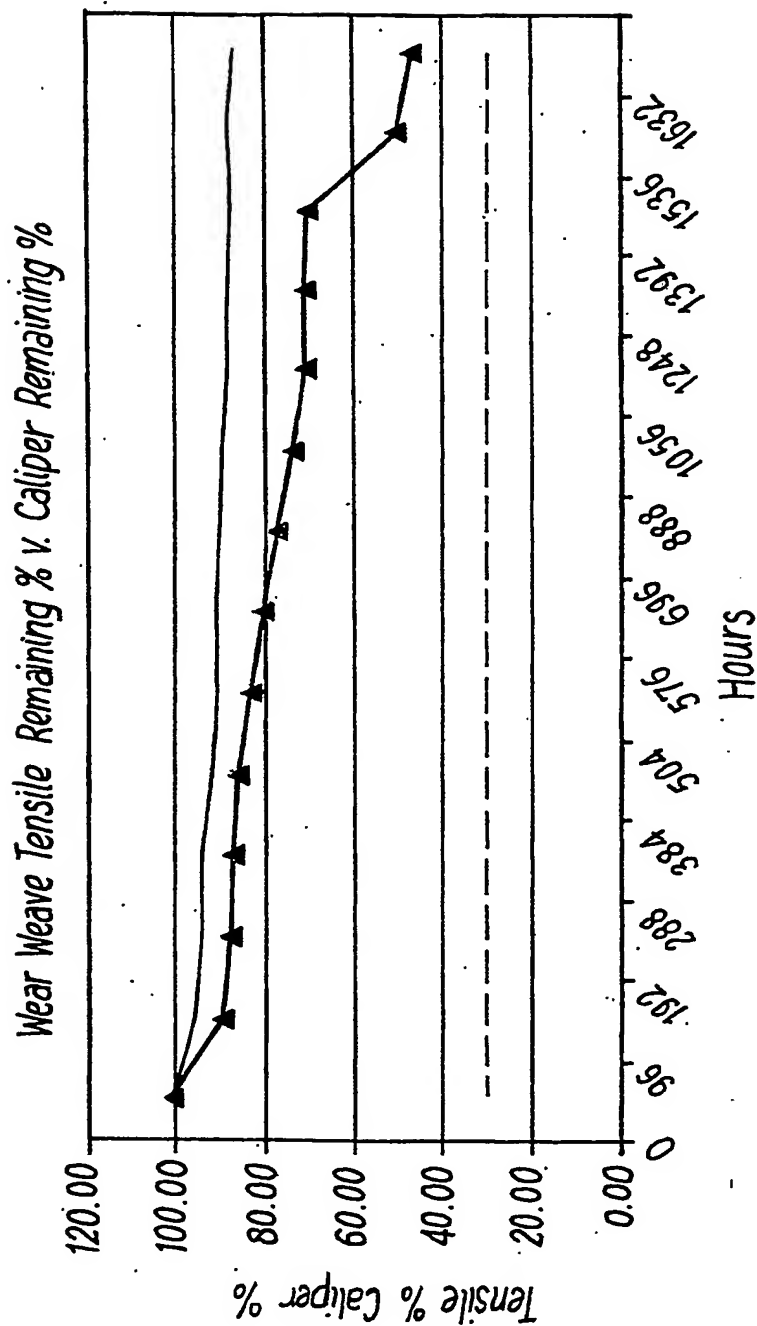


Fig. 5

- ▲— Tensile Remaining %
- % Caliper Remaining
- Critical Tensile % of Original

Abrasion Resistance Comparison Against "Art 1"

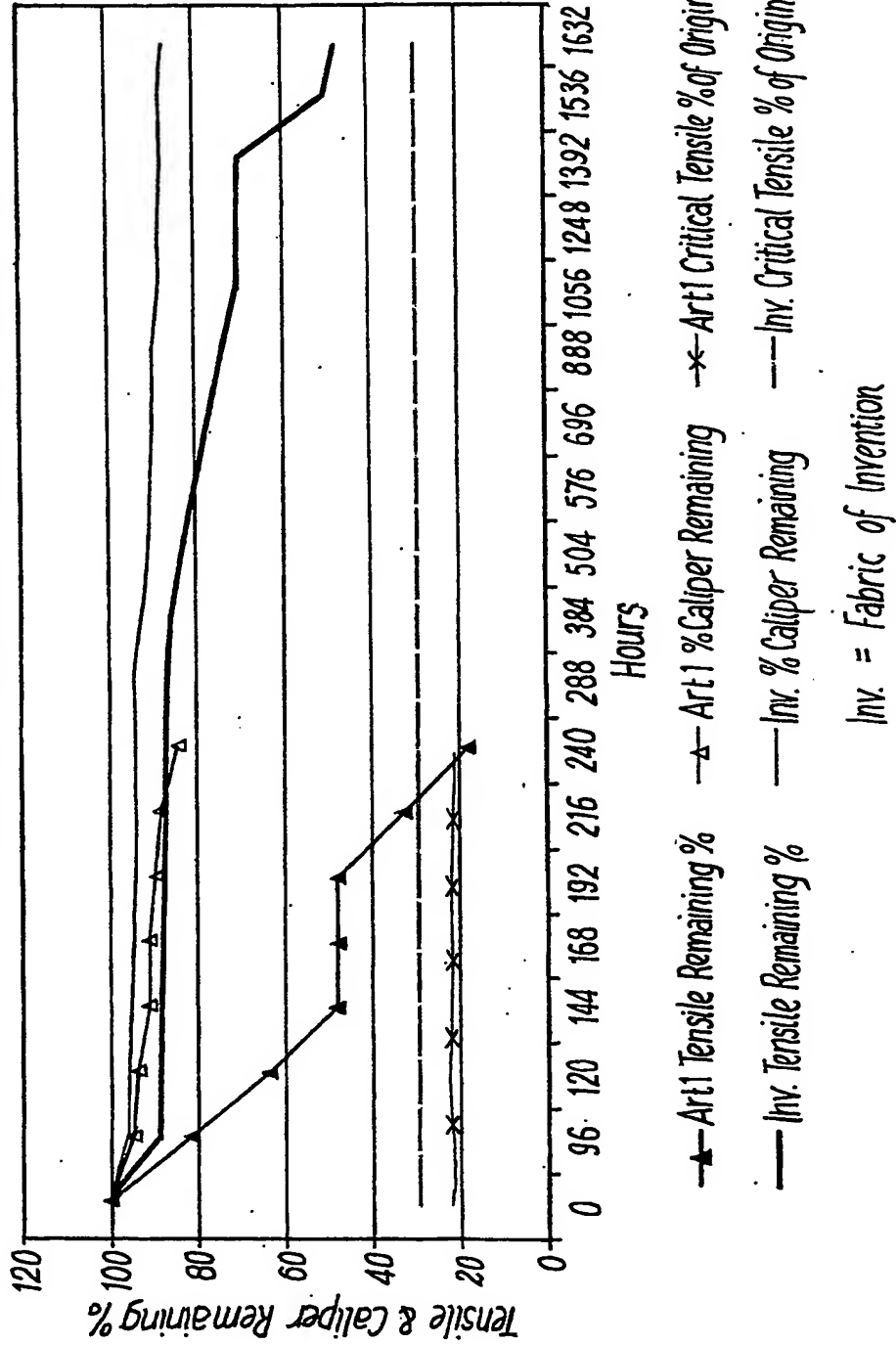


Fig. 6

Abrasion Resistance Comparison Against "Art 2"

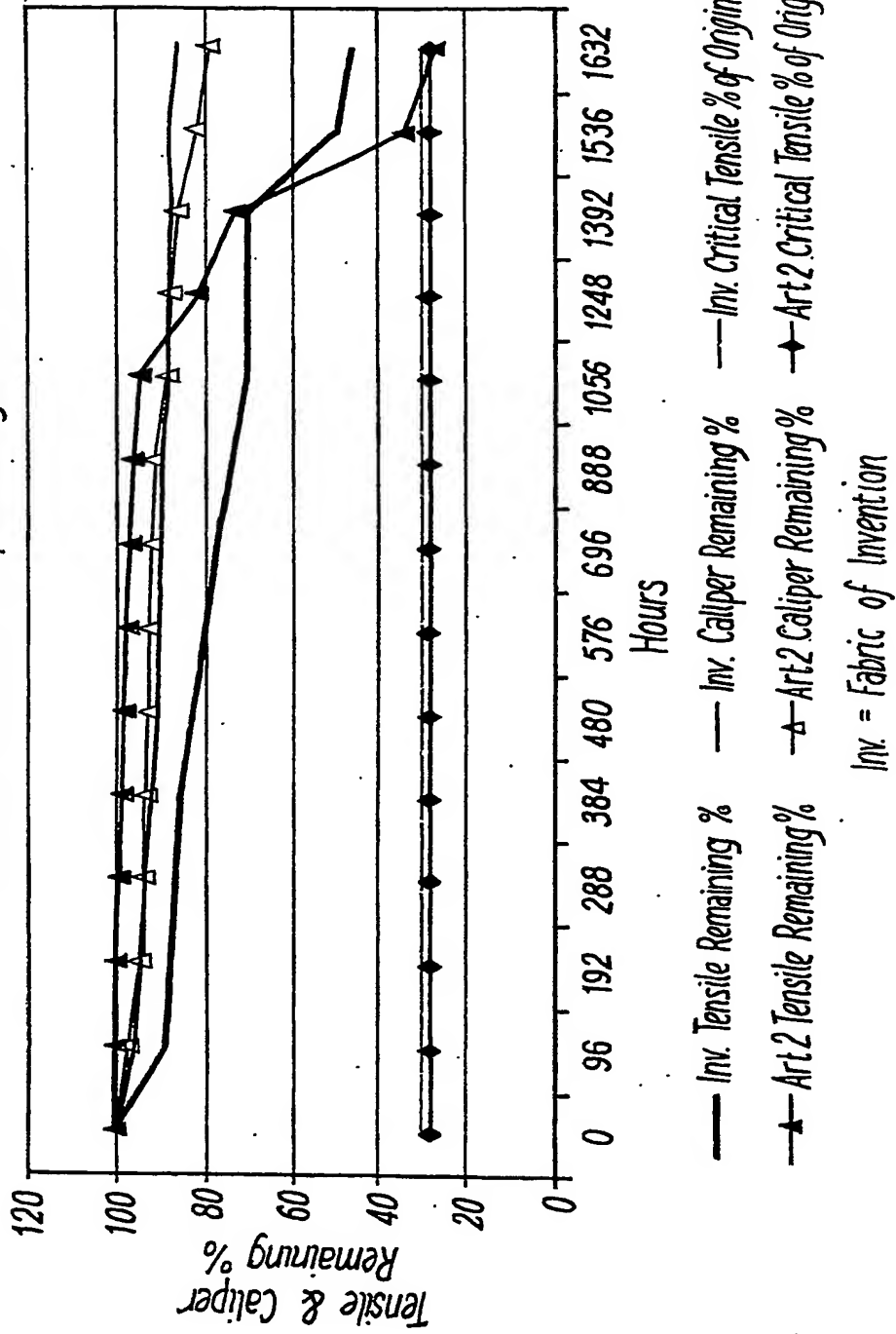


Fig. 1

INTERNATIONAL SEARCH REPORT

International Application No.

PCT/IB 03/05024

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 D21F1/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 D21F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 343 896 A (LEE HENRY J ET AL) 6 September 1994 (1994-09-06) column 4, line 62 -column 6, line 62 column 8, line 45 -column 9, line 44 column 10, line 66 -column 11, line 25 column 15, line 4 -column 16, line 4 figures 1,2,3A,6-8,21	1-15
X	US 2 854 032 A (SANTOS JOHN R L) 30 September 1958 (1958-09-30) column 1, line 15 - line 18 column 1, line 70 -column 2, line 12 column 2, line 46 -column 3, line 42 figures 1-3	1-4,6,8, 11,15

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

27 January 2004

Date of mailing of the international search report

10/02/2004

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PCT/ISA/23/05024

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